Stoller
Grand Junction Office established 1959

GJO-2003-531-TAC

# C4192
## Log Data Report

## Borehole Information:

| **Borehole:** C4192 | | | **Site:** 216-B-26 Trench | | |
|---|---|---|---|---|---|
| **Coordinates** (WA State Plane) | | **GWL (ft)[1]:** Not reached | | **GWL Date:** 11/13/2003 | |
| **North** | **East** | **Drill Date** | **TOC[2] Elevation** | **Total Depth (ft)** | **Type** |
| n/a[3] | n/a | Nov. 2003 | n/a | 40 | Percussion |

## Casing Information:

| Casing Type | Stickup (ft) | Outer Diameter (in.) | Inside Diameter (in.) | Thickness (in.) | Top (ft) | Bottom (ft) |
|---|---|---|---|---|---|---|
| Threaded Steel | 0 | 6 5/8 | 5 5/8 | 1/2 | 0 | |
| The logging engineer used a caliper to determine the outside casing diameter. The caliper and inside casing diameter were measured using a steel tape. Measurements were rounded to the nearest 1/16 in. Casing thickness was calculated. | | | | | | |

## Borehole Notes:

Zero reference is the ground surface. This borehole was logged through the drill pipe. The ground surface between 0 and about 1 ft is compacted gravel that was trucked in to stabilize the ground surface for drilling and logging operations.

## Logging Equipment Information:

| **Logging System:** | Gamma 2A | | **Type:** 35% HPGe (34-TP20863A) |
|---|---|---|---|
| **Calibration Date:** | 09/2002 | **Calibration Reference:** | GJO-2002-383-TAC |
| | | **Logging Procedure:** | MAC-HGLP 1.6.5, Rev. 0 |

| **Logging System:** | Gamma 1C | | **Type:** High Rate Detector |
|---|---|---|---|
| **Calibration Date:** | 04/2003 | **Calibration Reference:** | GJO-2003-429-TAC |
| | | **Logging Procedure:** | MAC-HGLP 1.6.5, Rev. 0 |

| **Logging System:** | Gamma 2F | | **Type:** Moisture (H380932510) |
|---|---|---|---|
| **Calibration Date:** | 09/2003 | **Calibration Reference:** | GJO-2003-520-TAC |
| | | **Logging Procedure:** | MAC-HGLP 1.6.5, Rev. 0 |

## Spectral Gamma Logging System (SGLS) Log Run Information:

| **Log Run** | **1** | **2/Repeat** | | | |
|---|---|---|---|---|---|
| Date | 11/13/03 | 11/13/03 | | | |
| Logging Engineer | Spatz | Spatz | | | |
| Start Depth (ft) | 39.0 | 5.0 | | | |

| Log Run | 1 | 2/Repeat | | | |
|---|---|---|---|---|---|
| Finish Depth (ft) | 1.0 | 1.0 | | | |
| Count Time (sec) | 200 | 200 | | | |
| Live/Real | R | R | | | |
| Shield (Y/N) | N | N | | | |
| MSA Interval (ft) | 1.0 | 1.0 | | | |
| ft/min | N/A[4] | N/A | | | |
| Pre-Verification | BA215CAB | BA215CAB | | | |
| Start File | BA215000 | BA215039 | | | |
| Finish File | BA215038 | BA215043 | | | |
| Post-Verification | BA216CAA | BA216CAA | | | |
| Depth Return Error (in.) | 0 | 0 | | | |
| Comments | Fine-gain adjustment after file 008. | Repeat section. | | | |

## High Rate Logging System (HRLS) Log Run Information:

| Log Run | 1 | 2/Repeat | 3 | 4/Repeat | |
|---|---|---|---|---|---|
| Date | 11/25/03 | 11/25/03 | 11/25/03 | 11/25/03 | |
| Logging Engineer | Spatz | Spatz | Spatz | Spatz | |
| Start Depth (ft) | 18.0 | 17.0 | 15.0 | 13.0 | |
| Finish Depth (ft) | 9.0 | 15.0 | 11.0 | 12.0 | |
| Count Time (sec) | 300 | 300 | 300 | 300 | |
| Live/Real | R | R | R | R | |
| Shield (Y/N) | N | N | Y - Internal | Y - Internal | |
| MSA Interval (ft) | 1.0 | 1.0 | 1.0 | 1.0 | |
| ft/min | N/A | N/A | N/A | N/A | |
| Pre-Verification | AC081CAB | AC081CAB | AC081CAB | AC081CAB | |
| Start File | AC082000 | AC082010 | AC082013 | AC082018 | |
| Finish File | AC082009 | AC082012 | AC082017 | AC082019 | |
| Post-Verification | AC083CAA | AC083CAA | AC083CAA | AC083CAA | |
| Depth Return Error (in.) | N/A | 0 | N/A | 0 | |
| Comments | Fine-gain adjustment after file AC82000. | Repeat section. | Fine-gain adjustment after file AC082013. | Repeat section. | |

## Neutron Moisture Logging System (NMLS) Log Run Information:

| Log Run | 1 | 2/Repeat | | |
|---|---|---|---|---|
| Date | 11/14/03 | 11/14/03 | | |
| Logging Engineer | Spatz | Spatz | | |
| Start Depth (ft) | 0 | 10.0 | | |
| Finish Depth (ft) | 39.5 | 14.0 | | |
| Count Time (sec) | N/A | N/A | | |
| Live/Real | N/A | N/A | | |
| Shield (Y/N) | N/A | N/A | | |
| MSA Interval (ft) | 0.25 | 0.25 | | |
| ft/min | 1.0 | 1.0 | | |
| Pre-Verification | BF113CAB | BF113CAB | | |
| Start File | BF113000 | BF113159 | | |
| Finish File | BF113158 | BF113175 | | |

| Log Run | 1 | 2/Repeat | | |
|---|---|---|---|---|
| Post-Verification | BF113CAA | BF113CAA | | |
| Depth Return Error (in.) | N/A | 0 | | |
| Comments | None | Repeat section. | | |

## Logging Operation Notes:

Zero reference was the ground surface, and the borehole was logged through drill pipe. Logging was performed with a centralizer installed on the sondes.

SGLS data were collected using Gamma 2A. Pre- and post-survey verification measurements employed the Amersham KUT ($^{40}$K, $^{238}$U, and $^{232}$Th) verifier with serial number 082.

HRLS data were collected using Gamma 1C. Pre- and post-survey verification measurements employed the $^{137}$Cs verifier with serial number 1013.

## Analysis Notes:

| Analyst: | Sobczyk | Date: | 12/01/03 | Reference: | GJO-HGLP 1.6.3, Rev. 0 |
|---|---|---|---|---|---|

SGLS pre-run and post-run verification spectra were collected at the beginning and end of the day and compared to the control limits. All of the verification spectra were outside the acceptance criteria. The photopeak counts per second (cps) at 2614.5 keV for the pre-run and post-run spectra were below the acceptance criteria. Examinations of spectra indicate that the recorded peak counts per second have slightly reduced calculated concentrations above 1500 keV, and the spectra are provisionally accepted.

HRLS pre-run and post-run verification spectra were collected at the beginning and end of the day. The spectra were within the acceptance criteria for the field verification of the Gamma 1C logging system (HRLS).

NMLS pre-run and post-run verification spectra were collected at the beginning and end of the day and compared to the control limits established on 12/05/2002. The spectra were within the acceptance criteria for the field verification of the Gamma 2F logging system (NMLS).

Log spectra were processed in batch mode using APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Post-run verification spectra were used to determine the energy and resolution calibration for processing the data using APTEC SUPERVISOR. Concentrations were calculated in EXCEL (source files: G2AFeb03.xls [SGLS] and G1CApr03.xls [HRLS]). Zero reference was the ground surface. On the basis of measurements supplied by the driller, the casing configuration was assumed to be one string of 6-in. casing to total logging depth (39 ft). The SGLS and HRLS casing correction factors were calculated using a 6-in. casing thickness of 0.5 in. This casing thickness is based upon the field measurement. A water correction was not required.

Using the SGLS, dead time greater than 40 percent was encountered in the interval from 10 to 17 ft, and data from this region are considered unreliable. At SGLS dead time greater than 40 percent, peak spreading and pulse pile-up effects may result in underestimation of activities. This effect is not entirely corrected by the dead time correction, and the extent of error increases with increasing dead time. SGLS dead time corrections were applied when dead time surpassed 10.5 percent.

The HRLS was utilized to obtain data where the SGLS dead time exceeded 40 percent. When HRLS dead time exceeds 30 percent, shields are used. In the interval between 12 and 14 ft, HRLS dead time exceeded 30 percent, and this interval was logged by the HRLS sonde with an internal shield installed. A shield correction factor has been estimated for 662 keV ($^{137}$Cs). This correction factor is 27.42.

NMLS log spectra were processed in batch mode using APTEC SUPERVISOR to determine count rates. The volume fraction of water was calculated in EXCEL, using parameters determined from analysis of recent calibration data. Zero reference was the ground surface. The neutron moisture calibration is based on a typical 6-in. casing with a thickness of 0.28 in., and the neutron moisture values were corrected for the 0.5-in. casing thickness.

## Log Plot Notes:

Separate log plots are provided for gross gamma and dead time, gross gamma and volume fraction of water, naturally occurring radionuclides ($^{40}$K, $^{238}$U, and $^{232}$Th), and man-made radionuclides. Plots of the repeat logs versus the original logs are included. For each radionuclide, the energy value of the spectral peak used for quantification is indicated. Unless otherwise noted, all radionuclides are plotted in picocuries per gram (pCi/g). The open circles indicate the minimum detectable level (MDL) for each radionuclide. Error bars on each plot represent error associated with counting statistics only and do not include errors associated with the inverse efficiency function, dead time correction, or casing correction. These errors are discussed in the calibration report. A combination plot is also included to facilitate correlation. The $^{214}$Bi peak at 1764 keV was used to determine the naturally occurring $^{238}$U concentrations on the combination plot rather than the $^{214}$Bi peak at 609 keV because it exhibited slightly higher net counts per second.

## Results and Interpretations:

$^{137}$Cs was the only man-made radionuclide detected in this borehole. $^{137}$Cs was detected throughout the entire length of the borehole at concentrations ranging from 0.4 pCi/g to 2.35 million pCi/g. The maximum concentration of $^{137}$Cs was measured at 12 ft.

The plots of the repeat logs demonstrate reasonable repeatability of the HRLS, SGLS, and NMLS data. $^{137}$Cs (662 keV) concentrations are comparable between the repeat and original HRLS log runs. $^{137}$Cs and the natural radionuclides at energy levels of 662, 609, 1461, 1764, and 2614 keV are comparable between the repeat and original SGLS log runs. The neutron-moisture and its repeat are within the acceptance criteria.

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[1] GWL – groundwater level
[2] TOC – top of casing
[3] n/a – not available
[4] N/A – not applicable

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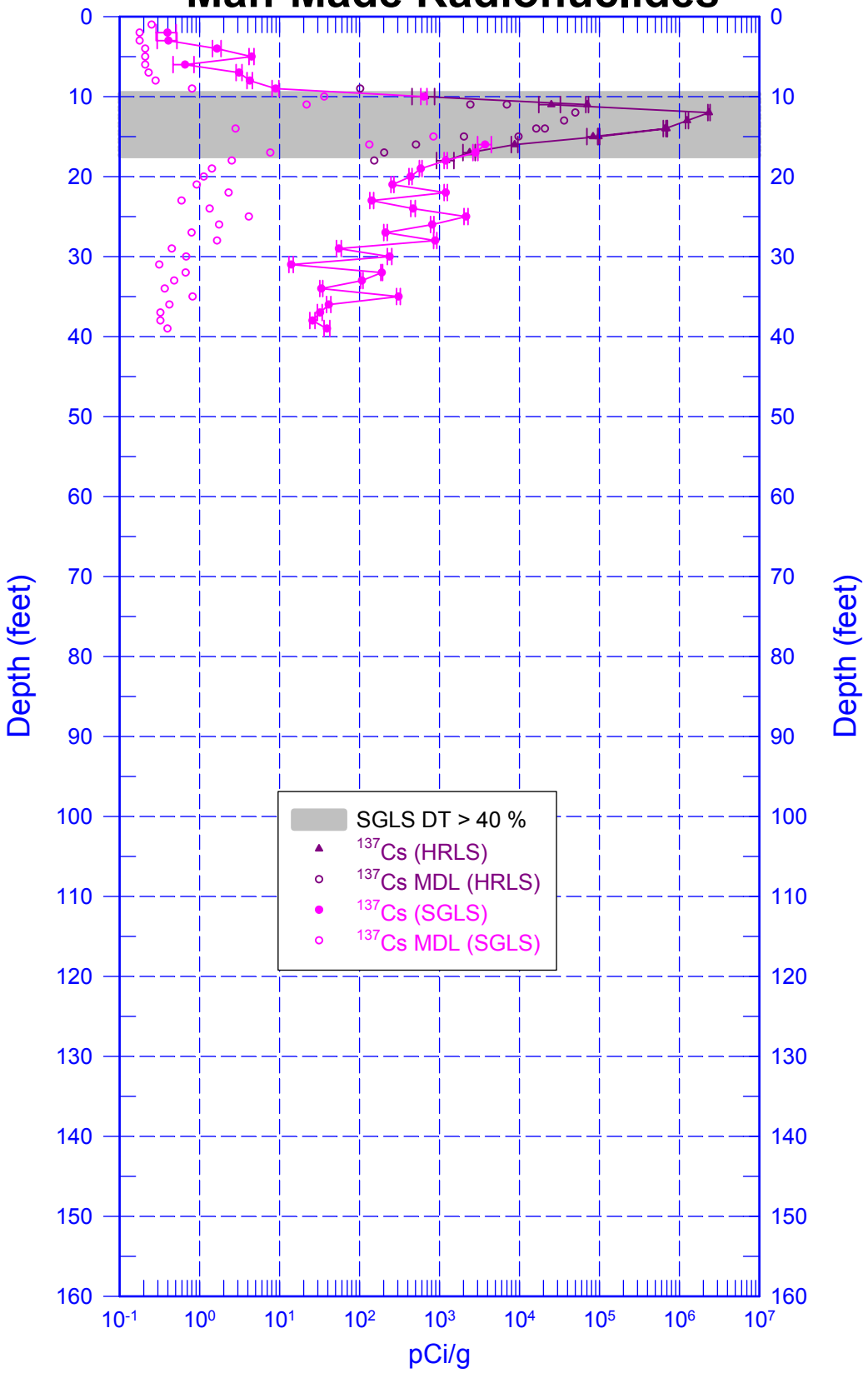
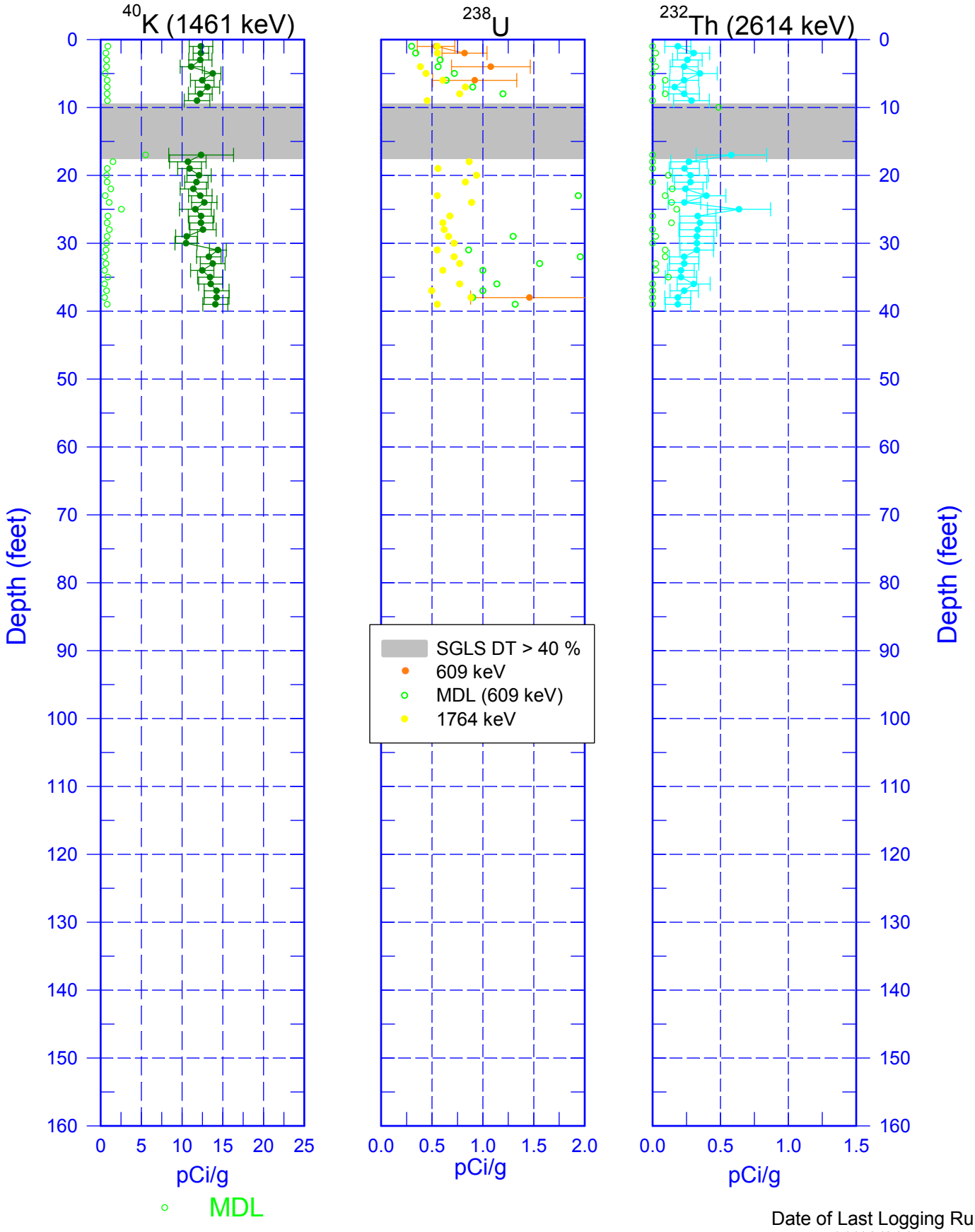
## Man-Made Radionuclides




Zero Reference = Ground Surface

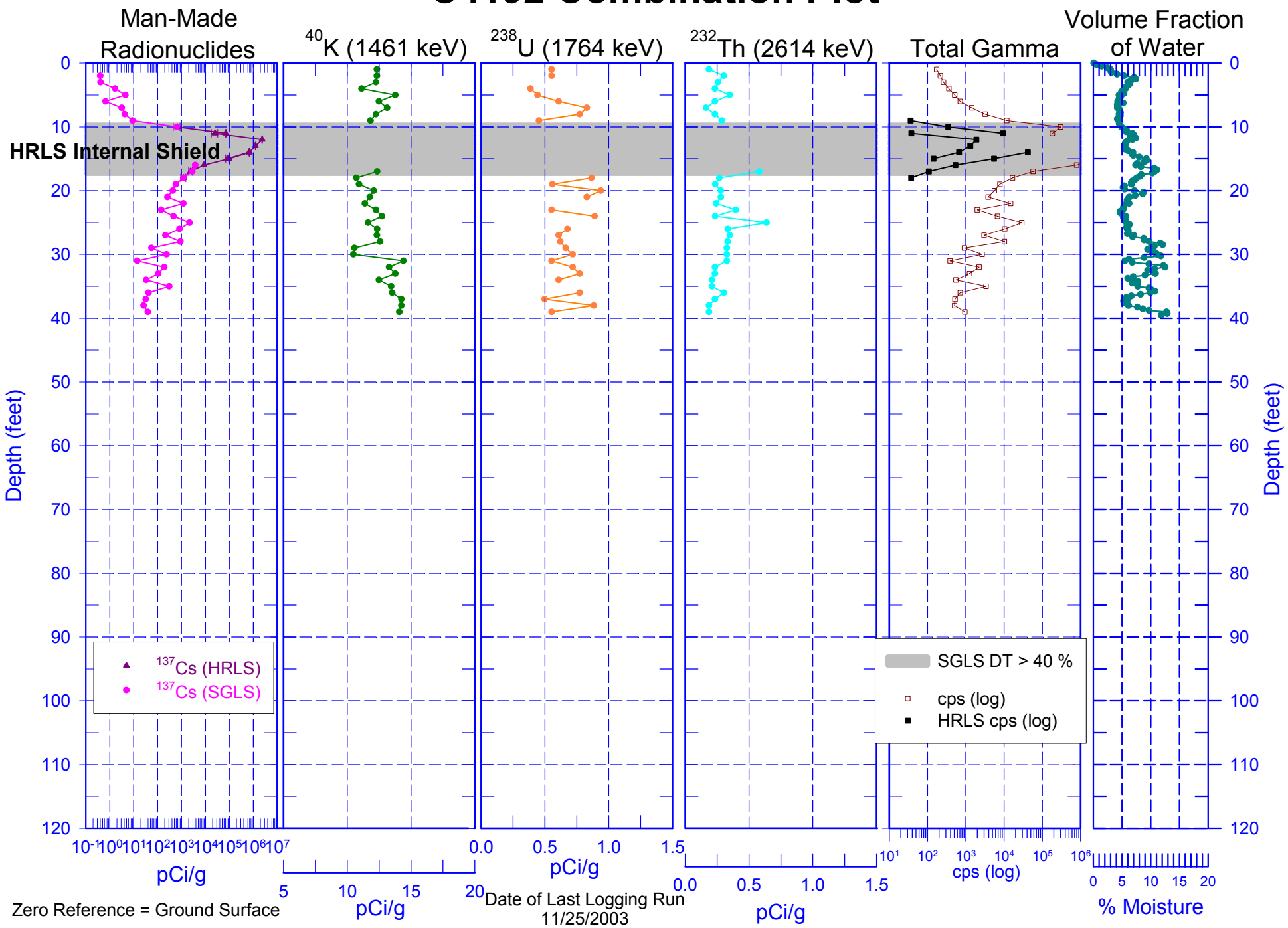
Date of Last Logging Run
11/25/2003

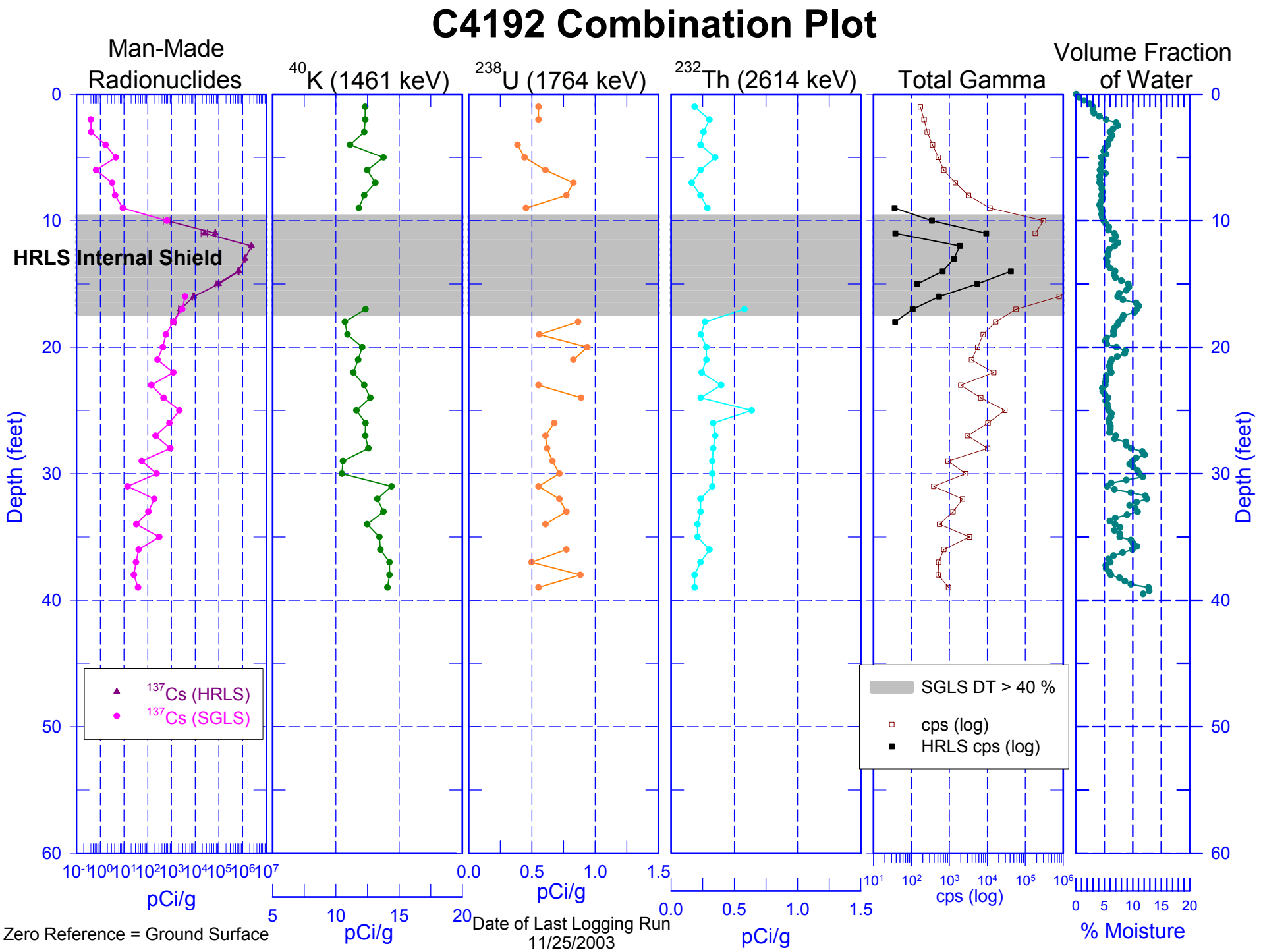
# C4192
## Natural Gamma Logs



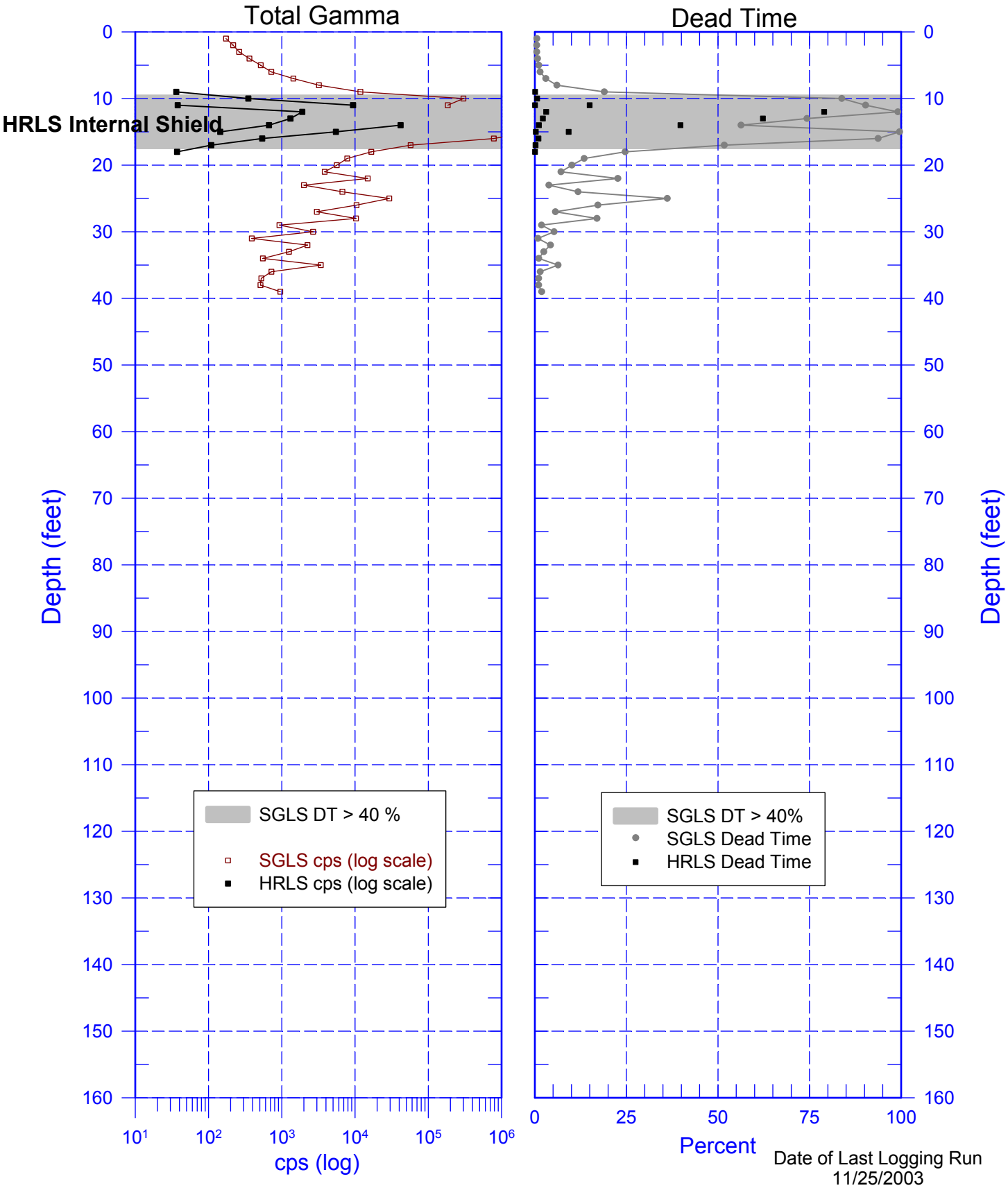

Zero Reference = Ground Surface

Date of Last Logging Run
11/13/2003


C4192 Combination Plot
Man-Made Radionuclides
40K (1461 keV)
238U (1764 keV)
232Th (2614 keV)
Total Gamma
Volume Fraction of Water
HRLS Internal Shield
Depth (feet)
137Cs (HRLS)
137Cs (SGLS)
SGLS DT > 40 %
cps (log)
HRLS cps (log)
pCi/g
cps (log)
% Moisture
Zero Reference = Ground Surface
Date of Last Logging Run
11/25/2003


C4192 Combination Plot
Man-Made Radionuclides
40K (1461 keV)
238U (1764 keV)
232Th (2614 keV)
Total Gamma
Volume Fraction of Water
HRLS Internal Shield
Depth (feet)
137Cs (HRLS)
137Cs (SGLS)
SGLS DT > 40 %
cps (log)
HRLS cps (log)
pCi/g
cps (log)
% Moisture
Zero Reference = Ground Surface
Date of Last Logging Run
11/25/2003

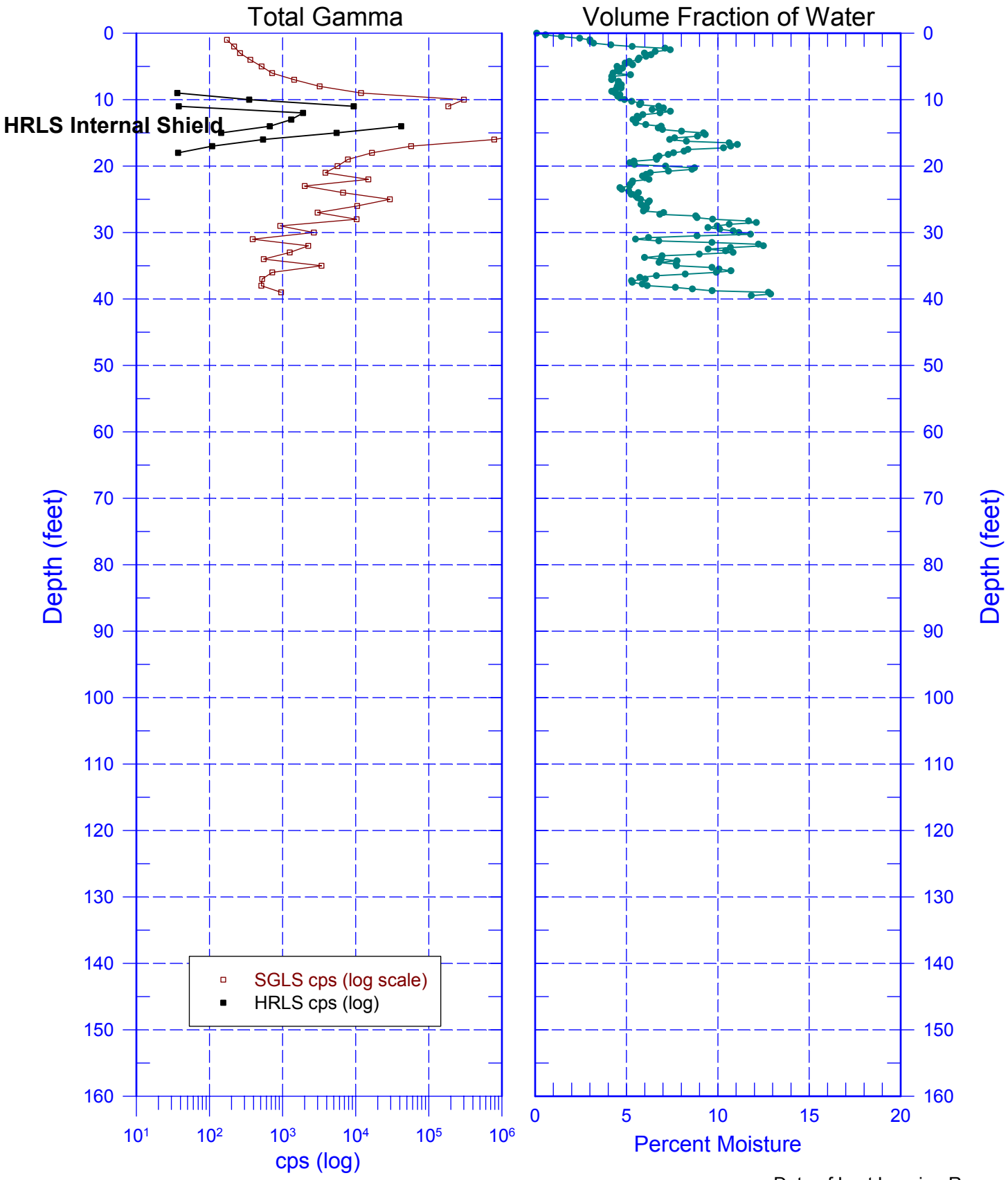
# C4192
## Total Gamma & Dead Time




Date of Last Logging Run
11/25/2003

Zero Reference = Ground Surface

# C4192
## Total Gamma & Neutron




Zero Reference = Ground Surface

Date of Last Logging Run
11/25/2003

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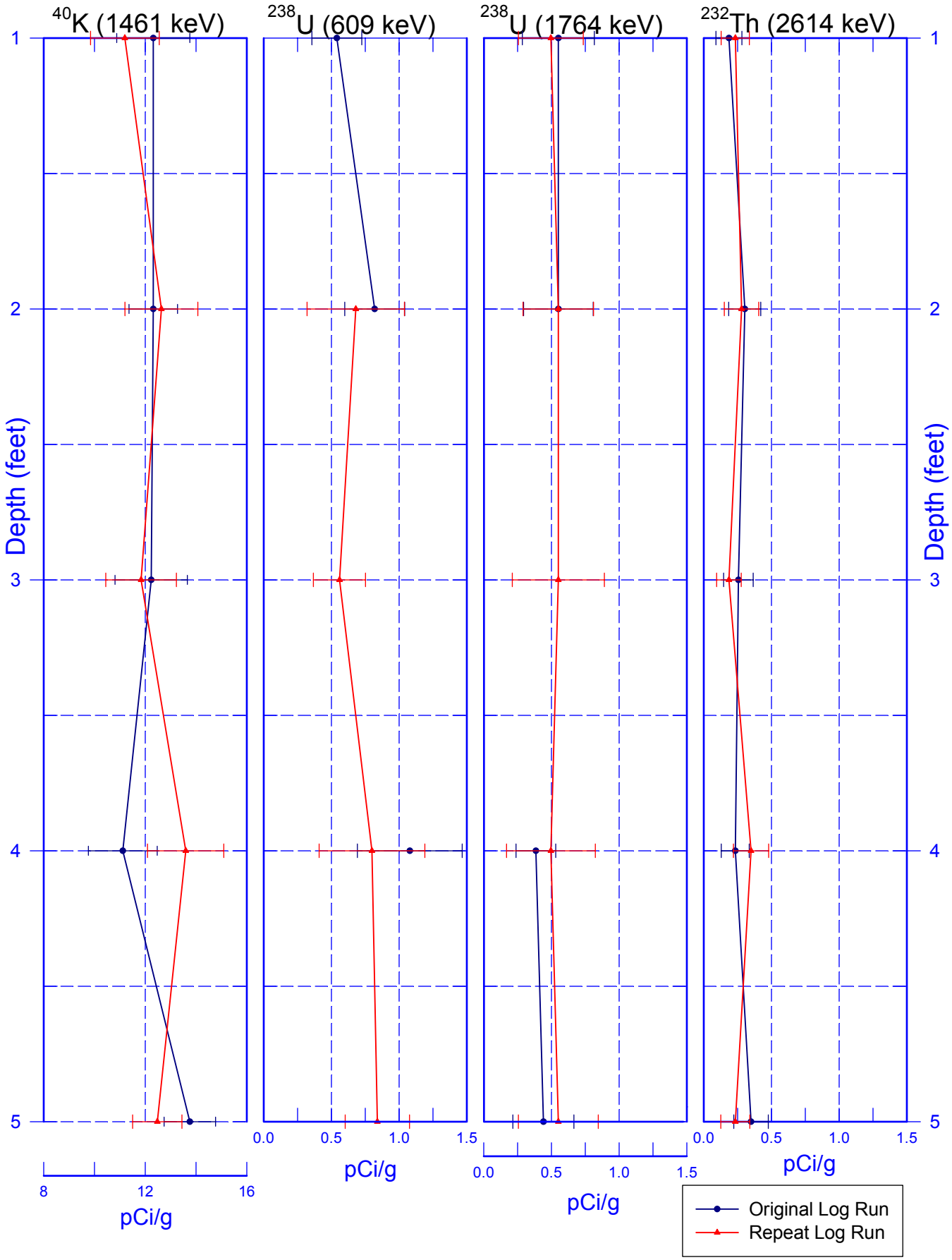
## Rerun of Natural Gamma Logs (5.0 to 1.0 ft)



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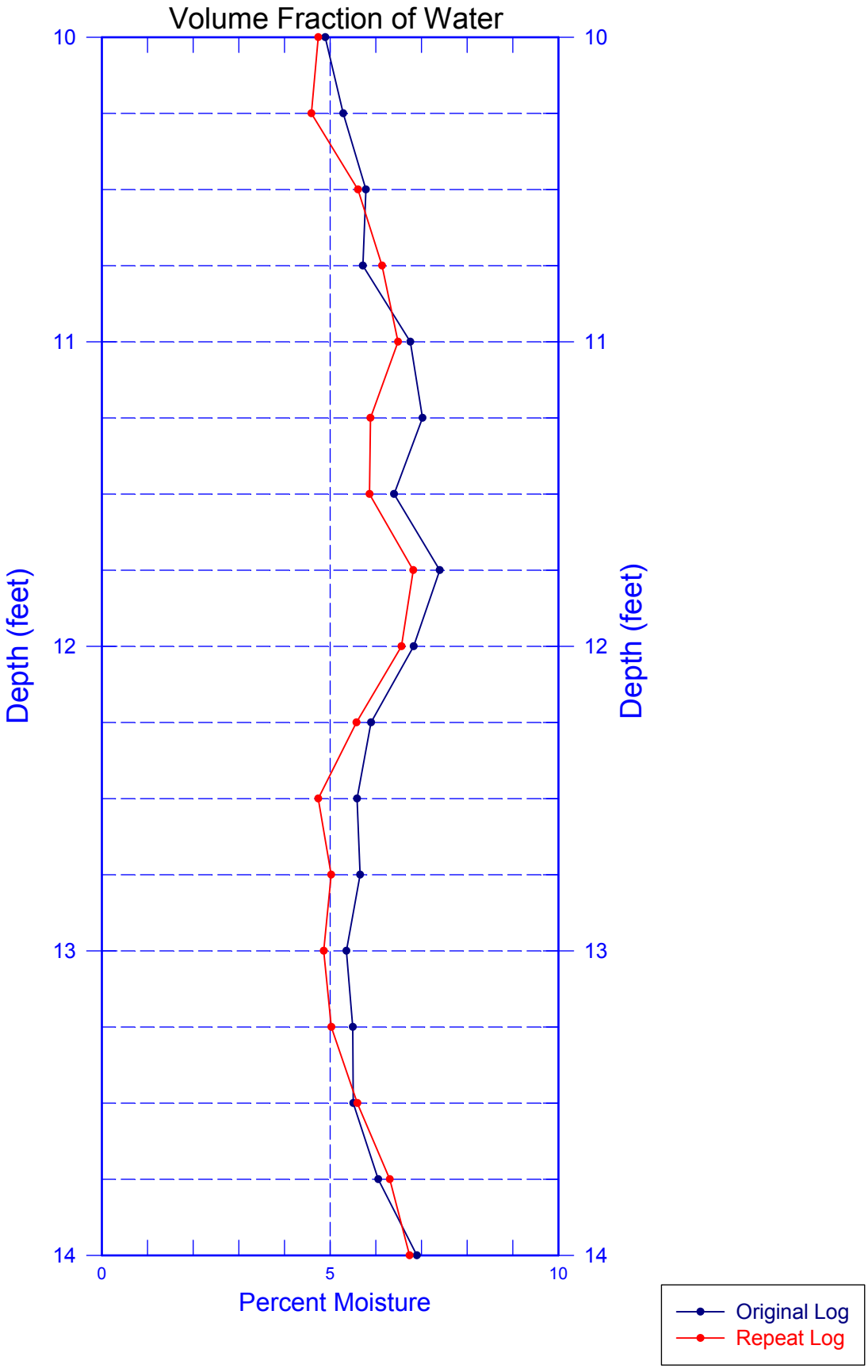
## Rerun of Neutron-Moisture Log (10.0 to 14.0 ft)



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## Rerun of Man-Made Radionuclides